Lattice Constant of Germanium Isotope

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It is well known that different crystalline isotopes of the same element have slightly different lattice constants. The effect is particularly visible at low temperature, when the lattice vibrations are only due to zero point energy. We have recently measured the lattice constant of ^{70}Ge with respect to that of standard Ge. Since the relative change $\Delta\alpha/\alpha$ is expected to be a few parts per million, a special diffraction technique had to be used. We made use of three-beam diffraction (the Renninger effect). The Ge crystal was set to diffract the forbidden reflection 600, and it was spun around the scattering vector. Big peaks are observed whenever the Ewald sphere intersects a node in reciprocal space. For some peaks, the position on the ψ scale (ψ = azimuthal angle) depends critically on the lattice constant. This happens whenever a node in reciprocal space crosses the Ewald sphere in a grazing mode. We measured the lattice constant α of ^{70}Ge, compared to that of natural Ge, at 3 temperatures (305 K, 100 K, and 20 K). While at 305 K we were not able to discern any difference between the two lattice constants ($\Delta\alpha$=0), there is no question that at 20 K the lattice constant α of ^{70}Ge is about 5 x 10^{-5} Angstroms smaller than that of natural Ge. The sign of $\Delta\alpha$ (negative) is surprising, because for ^{70}Ge $\Delta\alpha$ was found also negative by other authors. Since the nuclear mass of standard Ge is 72.3, a positive $\Delta\alpha$ was expected for ^{70}Ge. This result, if confirmed, would cast doubt on the validity of the so-called Virtual Crystal Approximation, which would predict a linear dependence of $\Delta\alpha$ vs A (mass number). Moreover, it is not clear whether or not a pure isotope with a given mass number A has the same physical properties (for example: lattice constant) as an isotopic mixture whose average mass is A.